CANTERBURY CHAMBER OF COMMERCE
AGRICULTURAL BULLETIN
No. 458 JAN./FEB., 1968.

TRACTOR SAFETY

By E. M. WATSON, Principal Research Officer, Lincoln College.

The Problem

During 1968 between 30 and 40 New Zealanders will lose their lives in tractor accidents. As the number of tractors in use in New Zealand increases, the death rate is likely to rise in the same proportion. This problem of tractor accidents is not peculiar to New Zealand and the subject has received attention in many parts of the world.

In 1965, the New Zealand Agricultural Engineering Institute at Lincoln College started an investigation into the causes of the accidents and possible methods of prevention. A considerable amount of work had already been carried out by Mr C. J. Crosbie of the Department of Agriculture, Christchurch, in collecting all the available recorded information about these accidents. A summary of 437 tractor fatalities which occurred in the period 1949 to 1966 is given below.

Type of Accident	No. of Fatalities
Tractor somersaulted forwards	15
Tractor somersaulted backwards	46
Tractor rolled over sideways	270
Run over (pedestrian or unseated driver)	64
Tractor moved after driver had alighted	15
Driver entangled with Power Take-off Shaft	10
Miscellaneous or information not available	17
	437

From these figures it can be seen that 75 per cent of all accidents involve the tractor overturning and in these cases death is usually a result of either crushing injuries or asphyxia. The remaining 25 per cent of the accidents are due to a wide variety of reasons. From an early date it was clear that the overturning accidents should receive priority attention.

Can Overturning Accidents be Prevented?

Many ideas have been suggested by inventors for preventing the tractor from overturning. These ideas are usually based on a device which measures the angle of tilt of the tractor and automatically takes a corrective action before the tilt becomes dangerous. The corrective actions suggested included switching off the engine, applying the brakes and extending rods to prevent the tractor overturning.

Whilst at first sight some of these ideas sound attractive, further study of the accident records show that a surprisingly small proportion of the overturning accidents occur on very steep country:

Slope on which tractor was travelling just prior to accident	%
0 - 9° Flat and slight slope	54
10 - 19° Moderate slope	20
20 - 29° Steep slope	20
Above 30° extremely steep	6
Total	100

A large number of accidents classified above as occurring on level or slightly sloping ground have been caused by the tractor rolling over an adjacent bank or into a ditch. This has been caused by such reasons as:

(i) The safe edge was obscured by growth.
(ii) Skidding.

(iii) Hitting an obstruction and temporarily losing control.
(iv) The driver looking backwards.

It quickly became apparent that in many accidents a safety device based on tractor tilt would operate too late to prevent the tractor overturning.

As part of the research programme about 40 actual accidents have been investigated and it is quite clear that few of the victims were either inexperienced drivers or being foolhardy. The majority of accidents are a result of a combination of circumstances, any one of which in itself, was insufficient to cause an accident.

From this evidence, it would appear that there is at present no practical engineering method of preventing tractors overturning. Thus the inescapable conclusion is reached that the best that can be done is to provide the driver with some protection from the danger of being crushed and the case for the safety frame is made.

The Case for the Safety Frame

In Sweden alone there are over 100,000 safety frames in use and to date there has been no reported case of a fatality as a result of the safety frame not protecting the driver during an overturning accident. The following table shows that the introduction of safety frames has had a pronounced effect in reducing the number of tractor overturning fatalities in Sweden during the period 1957-1966:—

No. of Tractors in Use	No. of Safety Frames in Use	No. of Fatalities
1957—156,000	not	23
1958—165,000	known	25
1959—176,000	exactly	34
1960—184,000	16,000	18
1961—195,000	28,247	33
1962—205,000	40,276	20
1963—215,000	53,264	15
1964—225,000	66,254	13
1965—235,000	89,554	17
1966—244,000	101,754	5

In New Zealand, there are over 1000 safety frames in use, and at least 12 of these have been involved in overturning accidents. In every case the driver survived and escaped serious injury.

Safety Frame Testing

To be acceptable, a safety frame must be strong enough to provide protection in the large majority of accidents. The design of a safety frame poses several engineering problems, not the least of which is the problem of finding adequate mounting points on the tractor itself. The N.Z.A.E.I. co-operated with the Standards Association of New Zealand in laying down a suitable test procedure in N.Z.S.S. 2146:1967. Since the issue of the Tractor Safety Frame Regulations in May 1967, it has become an offence to sell or fit a safety frame to an agricultural tractor unless the structural requirements of the Standard Specification are met. After satisfactory completion of the evaluation, which is carried out by N.Z.A.E.I. at Lincoln College, a Certificate of Approval is issued by the Labour Department. There are now approved frames available for about 40 models of tractor.

The procedure adopted is based on a test developed in Sweden but has been slightly adapted to cover the particular designs of safety frames which have been developed in New Zealand. The test is composed of three parts.

The first part of the test is an impact blow against the top of the frame in a longitudinal direction relative to the tractor. The blow is given by a pendulum weight weighing 4410lb and the severity of the blow imposed is dependent on the weight of the particular tractor being tested. During the test the tractor is securely fastened to the ground. After the impact the deflection of the frame must not exceed 4in.

The second part of the test is a similar impact test against the safety frame but this time in a lateral direction. The severity of this blow is greater than the preceding test but the deflection after the test must not exceed 10in.

In the third part of the test a vertical compressive load is applied on the top of the frame. The safety frame must withstand a load equal to twice the weight of the tractor.

Unfortunately this test cannot be applied directly to crawler tractors

and the N.Z.A.E.I. is at present carrying out further research to develop a suitable test procedure for crawlers. Up to the present time about 40 tests have been carried out and this experience shows that each tractor-safety frame combination must be considered separately. Due to the wide variety in mounting points on the tractors it is almost impossible to produce any "standard" designs.

It is interesting to note that the strength of the safety frame should be carefully matched to that of the tractor. Whilst a frame must obviously be strong enough to withstand collapse during an accident it must not be so strong that the tractor itself breaks. This is a very real problem due to the widespread use of cast iron in the tractor, this being a notoriously brittle material under impact conditions.

The Cost of Safety Frames

The retail price of a safety frame is dependent upon the design and whether features such as weather cladding are included. As a rough guide, however, a simple "roll-bar" frame may be obtained for $80-$100 whilst a complete safety frame including weather cladding may cost about $250. Any approved safety frame is a tax deductible item during the year of its purchase.

The Future

There is still a great deal of development work to be carried out before safety frames can be considered to be entirely satisfactory from the customers' point of view. Noise, vibration and lack of accessibility are problems on many present day designs. Behind the scene at the present time, however, the major international tractor manufacturers are preparing their own designs, and it would appear that these will fall into two categories.

(i) A simple "roll-bar", usually positioned just behind the driver to afford maximum protection in the event of overturning. A non-structural canopy may be attached to the top of the frame to give some sun and weather protection. This type of design is intended for countries with a mild climate.

(ii) A box-type of safety frame provided with complete weather cladding for countries with severe climates. It is possible to foresee that the addition of air conditioning units could make these designs very suitable for all types of climates.

Taking into account the facilities and resources of the large tractor manufacturing organisations, it would not appear an unduly rash prediction to foresee the day when the covered-in tractor will be as common a sight as a saloon car.

Copies of this Bulletin may be obtained from the Secretary, Canterbury Chamber of Commerce, P.O. Box 187, Christchurch. 10c per copy, 60c per dozen copies, or an annual subscription of $1.

THE RAVEN PRESS CO. LTD